Theory Manual

Principles of Seed Technology

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LIST OF TOPICS

1. INTRODUCTION

Seed Technology

Cowan, 1973: Seed Technology as that "discipline of studies having to do with seed production, maintenance, quality and preservation".

Feistritzer, 1975: Seed technology as "the methods through which the genetic and physical characteristics of seeds could be improved. It involves such activities as variety development, evaluation and release, seed production, processing, storage and certification"
Seed technology includes the development of superior crop plant varieties, their evaluation and release, seed production, processing, seed storage, seed testing, seed quality control, seed certification, seed marketing, distribution and research on seed these aspects. Seed production, seed handling based on modern botanical and agricultural sciences.

Nature: It is a multidisciplinary science encompassing a range of disciplines such as:
1. Development of superior varieties
2. Evaluation
3. Release
4. Production
5. Processing
6. Storage
7. Testing
8. Certification/quality control
9. Storage
10. Marketing and distribution
11. Seed pathology
12. Seed entomology
13. Seed physiology
14. Seed ecology

Scope
India is a vast country and bestowed with varied soils and has got different agro climatic zones, enabling year round cultivation of crops. By and large, most seed crops are grown during Kharif season. However most of the vegetable crops are produced in Rabi season and they posses better quality seeds than the crop grown in kharif. Indian farmers can practice with multiple cropping systems.

The farmers can opt for different crops like cereals, pulses oil seeds, vegetables, fibre crops, etc., in all the three seasons viz., Kharif, Rabi and summer.
With the advancement of agriculture, the government of India felt that there is a need to establish Seed Technology department in Agricultural Universities and ICAR institutes in India after the recommendations and suggestions given by National Commission on Agriculture. Accordingly, the Seed technology department was initiated throughout the country with the following main objectives,

1. To teach seed technology course.
2. Research on seed production/processing/testing.
3. To strengthen the seed technology research.

4. To give training to those who are involved in seed production, processing, testing, etc.

Goals of Seed technology

1. Rapid multiplication: To increase agricultural production.
2. Timely supply: New varieties must be available in time.
3. Assured high quality of seeds: Good vigour and viability.
4. Reasonable price: Cost of seed must be low to reach the average farmers.

Role of Seed Technology

Feistritzer (1975) outlined the following as roles of improved seed.

- A carrier of new technologies
- A basic tool of secured food supply
- The principal means to secure crop yields in less favorable production areas.
- A medium and rapid rehabilitation of agriculture in cases of natural disaster

Differences between seed and grain

Sl.No	Seed	Grain
1	It should be a viable and vigorous one	Need not be a viable one
2	It should be physically and genetically pure	Not so
3	Should satisfy minimum seed certification standards	No such requirements
4	It can be treated with pesticide /fungicide to protect seed against storage pests and fungi	It should never be treated with any chemicals, since used for consumption
5	Respiration rate and other physiological and biological processes should be kept at low level during storage	No such specifications
6	Should be compulsorily certified	No such condition in grain production
7	It should satisfy all the quality norms	Not considered
8	Seed can be utilized as grain provided if it is not treated with poisonous chemicals	Grain never can be converted into seed.

Difference between seed and grain production

Sl.No	Seed production	Grain production
1.	Planned programme –start with demand forecasting ends with marketing	well planning not required
2	Authenticated source is required to raise a seed crop	Need not be
3	Specific land and field requirements	Not so
4	Should be monitored for certification standards and certified by the Agency	Not so

5	To be harvested at physiological maturity	Harvestable maturity
6	Proper post harvest technology should be followed	Not so

In brief the role of seed technology in Agriculture sector is timely supply of quality seeds for reasonable price.

Characteristics of good quality seed

- It must be genetically pure

  Breeder /Nucleus - 100%
  Foundation seed - 99.5%
  Certified seed - 99.0%

- It should have the required level of physical purity for

  certification All crops - 98%

  Carrot - 95%

- It should have high pure seed percentage

  Bhendi - 99.0 %
  Other crops - 98.0 %
  Sesame, soybean &jute - 97 .0 %
  Ground nut - 96.0 %

- It should be free from other crop seeds, expressed in number /kg

Crop	Designated inseparable other crop seeds
Barley	Wheat, oats & gram
Oats	Wheat, gram & barley
Wheat	Oats, gram & barley

These are the plants of cultivated crops found in the seed field and whose seed are so similar to crop seed that is difficult to separate them economically by mechanical means. Cause physical admixture with the crop seed only when these crop mature approximately at the same time when seed crop matures.

- It should be free from objectionable weed seeds

These are plants of weed species which are harmful in one or more of the following ways.

- The size and shape of their seeds are so similar to that of the crop seed that is difficult to remove their seed economically by mechanical means.
- Their growth habit is detrimental to the growing seed crop due to competing effect.

- Their plant parts are poisonous or injurious to human and animal beings
- They serve as alternate hosts for crop pests and diseases.

Crop	Designated objectionable weeds
Berseem	Chicory(*Chicorum intybus*)
Cucurbits	Wild *Cucurbita* sp.
Kasuri methi	*Melilous* sp.
Lettuce	Wild lettuce(*Lactuca sativa*)
Bhendi	Wild *Abelmoschus* sp
Rape &Mustard	*Argemone mexicona*
Wheat	*Convolvulus arvensis*(Hiran kuri)
Paddy	Wild paddy (*Oryza sativa* var. Fatua)

- It should be free from designated diseases

It refers to the diseases specified for the certification of seeds and for which certification standards must be met with.

May cause contamination, when they are present in the seed field or with in the specified isolation distance in the case of loose smut of wheat. The FAO (Food and Agricultural Organization) prescribed 180 meters of isolation distance.

Crop	Designated disease	Causal organism
Wheat	Loose smut	Ustilago tritici
Sorghum	Grain smut or Kernel smut	*Sphacelotheca sorghii*
Mustard	Alternaria blight	*Alternaria* sp
Pearl millet	Grain smut Green ear Ergot	*Tolyposporium penicillariae* *Sclerospora graminicola* *Claviceps microcephala*
Sesame	Leaf spot	*Alternaria sp*
Brinjal	Little leaf	*Datura virus* 2
Chilies	Anthracnose leaf blight Leaf blight	*Gloesporium piperatum* *Alternaria solani*
Cucurbits	Mosaic	*Cucumis virus*
Cowpea	Anthracnose	*Colletotricum sp*
Bhendi	Yellow vein mosaic	*Hibiscus virus* 1
Potato	Brown rot Root knot nematode	*Pseudomonas solanacearum* *Meloidogyne incognita*
Tomato	Early blight Leaf spot	*Alternaria solani* *Xanthomonas vesicatoria*

- It should have good shape ,size ,colour, etc., according to specifications of variety
- Should have high physical soundness &weight

- It should posses high physiological vigour and stamina
- It should posses high longevity and shelf life
- It should have optimum moisture content for
  storage
  - long term storage - 8 % & below
  - short term storage -10-13%
- It should have high market value

2. GENERAL PRINCIPAL OF SEED PRODUCTION

Genetic Principle

1. Deterioration of varieties: Genetic purity (Truness to type) of a variety can deteriorate due to several factor during production cycles. The important factors of apparent and real deterioration of varieties) are as follows:

a. Developmental variation: When the seed crops are grown in difficult environment, under different soil and fertility conditions, or different climate conditions, or under different photoperiods, or at different elevation for several consecutive generations, the developmental variation may arise some times as differential growth response. To minimize the opportunity for such shifts to occur in varieties it is advisable to grow them in their areas of adaptation and growing seasons.

b. Mechanical mixtures: This is the most important source of variety deterioration during seed production. Mechanical mixtures may often take place at the time of sowing, if more than one variety is sown with same seed drill; through volunteer plants of the same crop in the seed field; or through different varieties grown in adjacent fields. Often the seed produce of all the varieties are kept on same threshing floor, resulting in considerable varietal mixture. To avoid this sort mechanical contamination it would be necessary to rogue the seed fields, and practice the utmost care during the seed production, harvesting, threshing and further handling

c. Mutations: This is not a serious factor of varietal deterioration. In the majority of the cases it is difficult to identify or detect minor mutation.

d. Natural crossing: In sexually propagated crops, natural crossing is another most important source of varietal deterioration due to introgression to genes from unrelated stocks which can only be solved by prevention

Natural crossing occurs due to following three reasons

i. Natural crossing with undesirable types .

ii. Natural crossing with diseased plants.

iii. Natural crossing with off- type plants.

Natural crossing occurs due to following factors

i. The breeding system of species

ii. Isolation systems

iii. Varietal mass

iv. Pollinating agent

a. Minor genetic variations: Minor genetic variations may exist even in the

   Varieties appearing phenotypically uniform and homogeneous at the time of their release. During later production cycle some of this variation may be lost because of selective elimination by the environment. To overcome these yields trials are suggested .

   Selective influence of diseases: The selective influence of diseases in varietal deterioration is also of considerable importance. New crop varieties often become susceptible to new races of diseases often caused by obligate parasites and are out of seed programmes. Similarly the vegetatively propagated stocks deteriorate fast if infected by viral, fungal and bacterial diseases. During seed production it is, therefore, very important to produce disease free seeds/stocks.

b. Techniques of plant breeders: In certain instances, serious instabilities may occur in varieties due to cytogenetically irregularities not properly assessed in the new varieties prior to their release. Other factors, such as break down in male sterility, certain environmental conditions, and other heritable variations may considerably lower the genetic purity.

Maintenance of Genetic Purity During seed Production:

The various steps suggested), to maintain varietal purity, are as follows.

a. Use of approved seed only in seed multiplication.

b. Inspection and approval of fields prior to planting.

c. Field inspection and approval of growing crops at critical stages for verification of genetic purity, detection of mixtures, weeds, and for freedom from noxious weeds and seed borne diseases etc.

d. Sampling and sealing of cleaned lots

e. Growing of samples of potentially approved stocks for comparison with authentic stocks.

The various steps suggested for maintaining genetic purity are as follows:

a. Providing adequate isolation to prevent contamination by natural crossing or mechanical mixtures
b. Rouging of seed fields prior to the stage at which they could contaminate the seed crop.
c. Periodic testing of varieties for genetic purity.

d. Avoiding genetic shifts by growing crops in areas in their adaptation only.
e. Certification of seed crops to maintain genetic purity and quality of seed.
f. Adopting the generation system.
g. Grow out tests.

Agronomic principles

1. Selection of a Agro-climatic Region

   A crop variety to be grown for seed production in an area must be adapted to the photoperiod and temperature conditions prevailing in that area.

2. Selection of seed plot

   The plot selected for seed crop must be free from volunteer plants, weed plants and have good soil texture and fertility The soil of the seed plot should be comparatively free from soil borne diseases and insects pests.

3. Isolation of Seed crops

   The seed crop must be isolated from other nearby fields of the same crops and the other contaminating crops as per requirement of the certification standards.

4. Preparation of Land

   Good land preparation helps in improved germination, good stand establishment and destruction of potential weeds. It also aids in water management and good uniform irrigation.

5. Selection of variety

   The variety of seed production must be carefully selected, should possess disease resistance, earliness, grain quality, a higher yielder, and adapted to the agroclimatic conditions of the region.

6. Seed treatment:

   Depending upon the requirement the following seed treatment may be given

a. Chemical seed treatment.
b. Bacterial inoculation for the legumes.
c. Seed treatment for breaking dormancy.

1. Time of planting

The seed crops should invariably be sown at their normal planting time. Depending upon the incidence of diseases and pests, some adjustments, could be made, if necessary.

2. Seed Rate

Lower seed rates than usual for raising commercial crop are desirable because they facilitate rouging operations and inspection of seed crops.

3. Method of sowing

The most efficient and ideal method of sowing is by mechanical drilling.

4. Depth of sowing

Depth of sowing is extremely important in ensuring good plant stand. Small seeds should usually be planted shallow, but large seeds could be planted a little deeper.

5. Rouging: Adequate and timely rouging is extremely important in seed production. Rouging in most of the field crops may be done at many of the following stages as per needs of the seed crop.

a. Vegetative / preflowering stage

b. Flowering stage

c. Maturity stage

1. Supplementary pollination

Provision of honey bees in hives in close proximity to the seed fields of crops largely cross pollinated by the insects, ensure good seed set thereby greatly increase seed yields.

13 .Weed control: Good weed control is the basic requirement in producing good quality seed. Weeds may cause contamination of the seed crop , in addition to reduction in yield:

14. Disease and insect control: Successful disease and insect control is another important factor in raising healthy seed crops. Apart from reduction of yield, quality the of seeds from diseased and insect damaged plants is invariably poor.

15. Nutrition:

In the nutrition of seed crops, nitrogen, phosphorus, potassium, and several other elements play an important role for proper development of plants and seed. It is,

therefore, advisable to know and identify the nutritional requirements of seed crops and apply adequate fertilizers.

16. Irrigation

    Irrigation can be important at planting for seed crops on dry soils to ensure good uniform germination and adequate crop stands. Excess moisture or prolonged drought adversely affects germination and frequently results in poor crop stands.

17. Harvesting of Seed crops:

    It is of great importance to harvest a seed crop at the time that will allow both the maximum yield and the best quality seed.

18. Drying of seeds:

    In order to preserve seed viability and vigour it is necessary to dry seeds to safe moisture content levels.

19. Storage of raw seeds: The best method of sowing seed for short periods is in sacks or bags in ordinary buildings or godowns.

3. GENERATION SYSTEM OF SEED MULTIPLICATION

Generation system of seed multiplication is nothing but the production of a particular class of seed from specific class of seed up to certified seed stage. The choice of a proper seed multiplication model is the key to further success of a seed programme which basically depends upon,

a. The rate of genetic deterioration
b. Seed multiplication ratio and
c. Total seed demand

Based on these factors different seed multiplication models may be derived for each crop and the seed multiplication agency should decide how quickly the farmers can be supplied with the seed of newly released varieties, after the nucleus seed stock has been handed over to the concerned agency, so that it may replace the old varieties. In view of the basic factors, the chain of seed multiplication models could be,

a. Three - Generation model

Breeder seed - Foundation seed - Certified seed

b. Four - Generation model

Breeder seed - Foundation seed (I) Foundation seed (II) - Certified seed

c. Five - Generation model

Breeder seed - Foundation seed (I)- Foundation seed (II) -Certified seed (I) - Certified seed (II)

Generation system of seed multiplication

Seed is the cheapest and basic input for sustained agricultural production. At the time of release of a variety, small quantity of seed normally known as nucleus seed is available with the plant breeder. Commercial quantity of seed is produced after a series of multiplication steps. Starting from maintenance programme in which nucleus seed is multiplied in a generation system of multiplication as breeder, foundation and certified seed.

Breeder seed

Breeder seed is produced from nucleus seed under thee supervision of a qualified plant breeder in a research institute of Agricultural University. This provide for initial and recurring increase of foundation seed. Breeder seed is monitored by a joint inspection team of scientists and officials of certification agency and National Seed Corporation. The genetic purity of breeder seed crop should be maintained at 100 per cent.

Foundation seed

Foundation seed is the progeny of breeder seed and is produced by State Farm Corporation of India, National Seed Corporation, State seed Corporation under technical control of qualified plant breeders or technical officers. Its production is supervised and approved by certification agency. The genetic purity of foundation seed should be maintained at 99.5 per cent.

Certified seed

Certified seed is the progeny of foundation seed and its production is supervised and approved by certification agency. The seed of this class is normally produced by the State and National Seeds Corporation and Private Seed companies on the farms of progressive growers. This is the commercial seed which is available to the farmers and its genetic purity should be 99 per cent.

Differences between certified seed and truthful labelled seed

Certified seed	Truthful labelled seed
Certification is voluntary	Truthful labelling is compulsory for notified kind of varieties
Applicable to notified kinds only	Applicable to both notified and released varieties
It should satisfy both minimum field and seed standards	Tested for physical purity and germination
Seed certification officer, seed inspectors can take samples for inspection	Seed inspectors alone can take samples for checking the seed quality.

Seed Multiplication Ratio

It is nothing but the number of seeds to be produced from a single seed when it is sown and harvested. According to expert group of seeds (1989), the seed multiplication ratio for different crops are as follows.

Crop	Seed Multiplication Ratio	Crop	Seed Multiplication Ratio
Wheat	1:20	Lucerne	1:25
Paddy	1:80 (Varieties)	Oats	1:15
	1:100 (Hybrids)	Bhendi	1:100
Maize	1:80 (Varieties)	Tomato	1:400
	1:100 (Hybrids)	Brinjal	1:450
Sorghum	1:100	Chillies	1:240
Bajra	1:200	Watermelon	1:100
Ragi	1:80	Pumpkin	1:160
Gram	1:10	Bittergourd	1:41
Blackgram	1:40	Bottlegourd	1:99
Greengram	1:40	Ridgegourd	1:83
Cowpea	1:40	Cucumber	1:200
Horsegram	1:40	French bean	1:9
Moth bean	1:40	Clusterbean	1:50
Red gram	1:100	Peas	1:19
Cole crops	1: 433	Onion	1:171
Potato	1:4	Radish	1:100
Groundnut	1:8	Carrot	1:83
Linseed	1:50	Mustard and rape	1:100
Cotton	1:50	Soybean	1:16
Jute	1:100	Sunflower	1:50
Mestha	1:40	Sesame	1:250
Sunhemp	1:30	Safflower and castor	1:60
Berseem	1;10	Lucerne	1:25

Seed Replacement Rate (SRR)

Definition

Seed Replacement Rate is the percentage of area sown out of total area of crop planted in the season by using certified/quality seeds other than the farm saved seed.

Seed Replacement Rates for Agricultural crops in Tamil Nadu (2008)

Sl.No.	Crop	State SRR
1.	Paddy	67.00
2.	Maize Variety & Hybrid	70.00
3.	Sorgum Variety & Hybrid	11.00
4.	Cumbu Variety & Hybrid	91.00
5.		
6.	Bengalgram	5.00
7.	Blackgram	42.00
8.	Greengram	21.00
9.	Redgram	6.00
10.	Groundnut	6.07
11.	Sunflower variety	13.00
	Cotton	100.00

Source: www.seednet.gov.in

The low replacement rate in groundnut indicates that farmers used the crop retained for seed purpose or obtained it from fellow farmers. However these seeds need not be of poor quality. The lateral exchange of seeds among the farmers may also help in diffusing new varieties faster. The low SRR adopted by government should be increased as proposed shown in table for proper diffusion of varieties / hybrids from seed production centres.

At public sector level, the NSC, SFC and State Seed Corporations are producing quality seeds and distributing to the farming community. The quality seeds produced in government owned seed farms and farmers holdings under seed farm agreement condition are being distributed through Agricultural Extension Centres to the farming community. The seed multiplication programme is handled by the Agricultural and Horticultural Departments in their State Seed Farms. There are certain practical difficulties in the production of quality seeds in government owned farms by the Agriculture and Horticulture departments, which are now responsible for non-availability of adequate quantities of seed materials to the farmers.

5. SEED CERTIFICATION

Seed certification is a legally sanctioned system for quality control of seed multiplication and production and which consists the control measures are

1. It is an administrative check on the origin of propagating material for the purpose of trueness to purity (genetic purity).
2. **Field inspection:** At the time of growing a crop for seed production purpose. The data should be obtained on trueness to varietals purity, isolation of seed crop to prevent crops- pollination, mechanical admixtures and diseases dissemination, objectionable weeds and admixtures.
3. Supervision on agricultural operations i.e. intercultural operations, harvesting, storage, transport and processing etc. for identity and quality of lots.
4. **Sample inspection:** For quality and to maintain genetic purity, a lab test of representative samples drawn by the S.C.A. for determining,% of germination moisture content, weed seed content, admixture and purity.
5. **Bulk inspection:** For checking homogeneity of the bulk as compared with the sample inspected.
6. **Control Plot Testing:** Samples drawn from the source seed and the final seed produced can be grown in the field along with standard samples of the variety.

The purpose of seed certification is to maintain and make available high quality seed and propagating materials of notified plant varieties.

Phases of Seed Certification

Seed certification has five phases of these are:

1. Verification of seed source.
2. Inspection of seed crop in the field.
3. Supervision at post-harvest stages including processing and packing.
4. Seed sampling and analysis.
5. Grant of certificate, certification tag, tables and sealing.

Steps Required for Organizing Seed Certification

The various steps are required for organizing seeds certification are:

1. Establishment and operation of seed certification agency.
2. Establishment of minimum seed certification standards.
3. Establishment of procedure for field inspection, seed processing, seed sampling and testing, tagging and sealing etc.

Seed Certification Procedure

Good quality seeds refer to seeds having optimum genetic and physical purity , high germination procedure percentage and seed with optimum moisture content. It also includes

seeds free from noxious weed seed and other crop seeds and free from seed borne diseases. To meet these criteria there is a need of certification.

Seed Certification:

Seed certification is a legally sectioned system for quality control of seed during seed multiplication and production. Seed certification is a scientific and systematically designed process to secure, maintain, multiply and make available seeds of notified and released varieties to the farmers.

Object of Seed Certification:

1) To ensure genetical identity of a variety.
2) To ensure high degree of physical purity.
3) To ensure high degree of germinability.
4) To ensure freedom from all designation seed borne disease, weeds and other crop seeds.

According to statutory rules and regulation of seed act (1966), autonomous government organization such as state seed certification Agency is established. Procedures for registration, field inspection, seed processing, release sampling, seed testing , issue of seed certification tags and seals and release of seed lots are established.

Phases of Seed Certification:

1) Receipt and security of application with notarized agreement for registration of seed plot for certification.
2) Verification of seed source, class used for raising the crop by checking certification tags, lablels, seed containers , cash memo or bills.
3) Field inspections of the seed plot to verify conformity to prescribed field standards.
4) Post harvest supervision of seed crop including sealing raw seed , issue T.C . supervision during seed processing at registered seed processing plant.
5) Seed sampling and sending sample to STI for analysis to verify conformity to prescribed seed standards as well as genetic purity(field test).
6) Grant of certification, tagging and sealing of the containers – Release of seed lot for seed multiplication or marketing for commercial.

Requirements of Certified Seed Production

1) Source of Seed:

Appropriate / proper class of seed need to be obtained from approved source according to stages of seed multiplication. In case of foundation seed, breeder seed with yellow or buff coloured tag is to be used for sowing while for certified seed production, certified foundation seed with white tag is to be used. While purchasing the breeder or foundation seed, following precautions are to be taken.

a) The bags containing breeder seed or foundation seed should intact with lead seals not tampered or removed.
b) Certification tag i.e yellow tag for breeder seed and white tag for foundation seed should be stitched to the bag and intact. It should be signed by seed certification officer / crop

breeder.
c) While procuring the seed, period of validation or revalidation noted on the tag be checked. If the validity or revalidation period of the tag is expired, the seed should not be used for seed production. The source of purchased seed should be verified by SCA before sowing.
d) The empty bags and the tags should be preserved properly till the seed is certified. It helps in giving documentary evidence if legal dispute arises. The tags are also required to be produced at the time of field inspections.

Generally seeds of notified varieties are multiplied in four tier system i.e nucleus seed, breeder seed, foundation seed and certified seed.

2) Registration of Seed Plot:

When the seed plot is to be offered for certification, it is necessary to register the said plot for certification with District Seed Certification Officer. For this an application is to be made in prescribed form (Form A) and is to be submitted to District Seed Certification Officer along with agreement bond on stamp paper with requisite fee.

3) Land Requirement:

a) The land selected for seed production should be suitable for that crop. It should be medium to deep and well drained light soils, sandy soils or waterlogged soils should not be selected for seed production as such lands affect crop growth and thereby reduce the seed yields.
b) The land selected for seed production should be comparatively free from soil borne diseases, insect pests and noxious weed seeds.
c) As far as possible the land selected for seed production should not have same crop grown in the proceeding season. However, if same crop is grown in the proceeding season, then it should be irrigated three weeks before sowing so that seed of preveious crop that had fallen the soil will start germination. The land should be harrowed for removing seedlings of volunteer plants, weeds, other crop plants.
d) It is desirable to have protective irrigation source.
e) The selected land should meet isolation requirement.

4) Isolation Requirement:

Isolation is the separation of seed field from the fields of
a) Other varieties or hybrids of same crop.
b) Same variety of hybrids which do not conforming to varietal requirements.
c) Other related species which are readily crossable and
d) Fields affected by designated diseases prevent genetic and disease contamination.

When a seed plot is grown in isolation, it ensures that no cross pollination takes place. Plants from the seed plot and plants of same species or closely related species thereby help in maintaining the genetic identity of the seed plot. Isolation of seed plot can be maintained by two ways i.e
a) Time isolation and b) Space isolation. In case of time isolation, sowing of seed plot is adjusted in such a manner that the seed plot does not came to flowering at the same time with the neighbouring crop of same variety or other variety of the same crop or related species. Sowing of the seed plot is usually carried 15 to 21 days before or after emergence of the neighbouring crop. This time isolation helps is preventing the genetic contamination of the

seed crop as seed plot comes to flowering either before or after the neighbouring crop completes its flowering time isolation is not allowed in certified seed production.

Space Isolation:

Space isolation is the minimum distance kept between the seed plot and neighbouring plot of same crop which prevents natural cross pollination and physical contamination. During pollination, pollens are carried from one plant to other either through air or insects. The pollens remain viable for some period before they reach stigma of female flower for pollination. The viability period of pollens which varies according to the species depends upon the size and weight of pollens, and climatic conditions viz. air temperature and air humidity. In case of cross pollinated crops, pollens are liberated in air and are carried thought air to some distance before they reach stigma. The distance upto which pollens are carried in viable conditions varies according the species which in turn, varies according to weight of pollens. E. g In case of highly cross – pollinated crops the isolation distance is much higher as the pollens of these species can travel longer distance in viable condition. In case of self pollinated crops as pollination occurs before opening of the flowers, isolation distance is less to prevent physical contamination.

Sr.No	Crop	Mode of Pollination prescribed (mtrs)	Foundation Distance	Certified Distance
1	Rice, Wheat, groundnut, soybean	Self Pollinated	3	3
2	Jowar (Open pollinated varieties), Tur , sunflower	Often cross pollinated	200	100
3	Cotton, Jute	Often cross pollinated	50	30
4	Jowar hybrids	Cross pollinated	300	200
5	Maize a) Inbreeds and single crosses b) Hybrids c) Composites	-	400	-
6	Mustard, Sunflower	-	400	200
7	Bajara (Hybrid)	-	1000	200
8	Lucerne , Berseem	-	400	100
9	Cole Crops	-	1600	1000
10	Gram	Self Pollinated	10	5

It is necessary to maintain prescribed isolation distance on all sides of the seed crop throught the cultivation of seed crop. The seed producer should visit all areas surrounding the seed plot which lie within the isolation distance and see that no plants belonging to the crop of seed plot of its closely related species comes to flowering. Such plants should be removed before they set flowers.

5) Cultivation Practices and Plants Protection:

Cultivation practise recommended for the crop are required to be adopted timely so as to get good stand of seed crop and thereby higher seed yields. It consists of
a) Good land preparation.
b) Use of optimum seed rate with timely sowing.

c) Application of FYM and fertilizers at recommended doses and as per schedule of split application.
d) Timely weeding and Interculturing.
e) Timely control of pests and diseases.
f) Timely application of irrigations.
g) Watching the seed plots from birds, stray animals.

6) Roughing:

Rouge is an undesirable plant or off type growing in the seed plot. Roughing is the removal of individual plants which differ significantly from the normal type of the variety. The most important object of the seed production is to maintain genetic purity of the variety or hybrids seed plot. For this purpose it is necessary to follow rouging vigorously.

Rouging consists of removal of
a) Off types
b) Volunteer plants
c) Pollen shedders in female (A) lines,
d) Plants of noxious weeds and other crops,
e) Diseased plants affected by seed borne diseases growing in the seed plot and
f) Tassels from plants in the female rows of seed production of single hybrids and double hybrids in maize.

It is necessary to carry rouging vigorously and punctually throughout the crops growth i.e till harvesting. Rouging is to carried in three phases. i.e a) Pre Flowering During Flowering and c) Post flowering or before harvesting. During pre-flowering period plants which are morphologically distinguishable from true characters of the variety should be removed. Similarly volunteer plants, other crop plants, weed plants should also be checked. During flowering period which lasts for 15 to 30 days rouging should be carried more critically and all off types, volunteer plants, and pollen shedders in M.S lines should be removed before shed pollens. Timely rouging during flowering helps in preventing natural cross pollination and also reduces the proportion of off types. Simultaneously isolation area on sides of seed plot be checked for removing volunteer plants before they flower. Plants affected by seed borne diseases, other crop plants and tall growing weed plats should also be removed. In case of seed plots of both single and double hybrids of maize work of detasseling should be carried in female lines before they shed pollens.

Roguing should be continued during seed development stage and before harvesting for removing visibly distinct off types other crop plants and diseased plants. Post flowering rouging is admissible in seed production of self pollinated crops.

7) Field Inspection:

As per provisions of seed certification, the seed plots offered for certifications are subjected to field inspection by the staff of seed certification agency. The number of field inspections is usually carried without prior intimation to the seed producer. It is the responsibility of the seed producer to follow the instructions given by the field inspector. For this purpose seed producer or his responsible representative remain present on the field during each inspection. During the field inspection, source of seed used with tag isolation planting rouging are checked and counts of off types, shedders etc are taken. A copy of inspection report is handed

over to the producer. Seed producer should see that all operations required to maintain prescribed genetic and physical purity of seed plot are carried before each inspection, otherwise carelessness on part of the seed producer may result in rejection of seed plot from certification.

8) Harvesting, Threshing, Drying and Sealing of Raw Seed:

Seed plot should be harvested at proper stage of maturity and only after permission is granted by the field inspector. After harvesting the crop, it should be brought to threshing yard for drying care should be taken to see that there will not be contamination with other varieties in the produce of seed plot. The seed produce be threshed and winnowed for removing major part of inert matter. i. e Stones, sand , dried twigs, leaves, husk etc. The cleaned seed produce should be bagged in the presence of the field inspectors who ill seal the entire bags ad issue threshing certificate. At the time of sealing, field inspector draw 3 kg sample from each lot. In case of F/S and certified cotton seed for F.T. The seed bags should be transported to authorized seed processing plant for processing along with threshing certificate.

It may be noted that the seed will not be accepted for processing at seed processing plant unless it is brought in bags sealed by the field inspector and issued with threshing certificate.

9) Seed Processing:

Seed lot accepted for processing is processed at the seed draws three samples and sends one sample to seed testing laboratory for testing laboratory for testing, one sample kept at his disposal and one sample for concerned seed producer.

10) Bagging, Tagging:

When the seed lot is passed by seed certification agency on the basis of seed testing laboratory report (STL). The processed and treated seed is bagged and tagged with appropriate tags issued by seed certification officer.

11) Release of Seed Lot:

The certified seed lot is released to the seed producer for sale. But foundation seed lot is released after getting FT report.

Harvesting:

1) The seed crop should be taken from seed certification officer for harvesting the seed plot.
2) The crop is harvested by taking care to ensure that there will be no physical contamination with neighbouring crop.

Drying:

The initial moisture content of freshly harvested seed is usually high in between 15 to 25% .It is therefore necessary to dry the seed produce to bring its moisture content to safe level of 12% or less. For this purpose , the harvested material is dried in sun light for 4 to 6 days. During drying , the produce should be turned over frequently so that all portion of the produce is exposed to sun and also it facilitates free air circulation.

Threshing:

After proper drying the seed produce is to be threshed by using bullocks, tractors, or suitable thresher. The thresher should be thoroughly cleaned from inside for removing seed of preveious crop. The speed of the thresher should be adjusted by choosing appropriate size of pulley so as to prevent mechanical damage to the seed.

After threshing, the produce should be winnowed for removing husk, bhusa and other trash material.

In case of groundnut, pods are removed from the plants by twisting with hands or by beating the plants on wooden plank. All dry leaves, twigs and soil pieces etc should be removed. Then the pods are sieved for removing shrivelled and undersized pods.

When the seed produce is properly dried, threshed and cleaned, raw seed is filled in gunny bags and after putting the threshing slip inside the gunny bags, these gunny bags are sealed by seed certification officer and marked the gunny bags with all details of seed information. The sealed seed produce is transported to the seed processing plant for further processing along with threshing certificate, if the produced seed is to be transported to other district processing plant to obtain interdistrict transport certificate from district seed certification officer and submit the same to the seed processing plant, it is subjected to processing which consist of following steps. All seed processing done under the supervision of Agril Officer of S.C.A.

Field Inspection in Seed Production

It is a key method in the whole process of certification for the verification of the seed quality when the crop is standing in the field and is subjected to the vagaries of weather and exposed to other known and unknown factors affecting its quality.

Field inspections are done by the seed certification inspector (Field inspector) from SSCA by examining seed crop in the field right from sowing upto harvesting. They verify key factor like, genetic purity, physical purity, seed health, which deteriorate seed quality in the field.

Inspection of Seed Crop in Standing Field is Field Inspection in Broad Sence:

Field Inspection is defined as inspection of standing crop in seed field by the seed certification officer or field inspection of SSCA to confirm isolation, genetically purity and timely rouging of contamination and other agronomical seed production practices for their fulfilment of prescribed standards (or) norms of SCA.

Objective of Field Inspection:

1) Verification of seed source.
2) Verification of cropping history of land for processing season or year.
3) Verification of Isolation.
4) Checking of planting method followed i.e planting ratio, border rows, in case hybrid seed production.
5) Rougeing of off types, diseased plants and other mechanical contaminants.
6) Guidance to seed growers.

Crop Stage for Field Inspection in Seed Technology

The number of field inspection required to be conducted depends upon the nature and pollination behaviour of the seed crop.

1) Self pollinated crops – 2 inspections.
2) Often crops pollinated crops 2 to 3 inspections.
3) Cross pollinated crops. Hybrids – 4 inspections.

The appropriate stages for field inspection of seed plots are
1) Pre-flowering stages.
2) Flowering stages (may be II,III or IV)
3) Pre-harvest stage and
4) Post harvest stage.

Any additional field inspection conducted over and above the minimum number will be beneficial the key points to be observed at each inspection, are as under.

Stages of Crop	Inspection Number	Key Points to be Observed
1) Sowing to	I	1. Varietals eligibility for verification.2. Verification of

Pre-flowering		source of seed.3. Land Requirement.4. Isolation distance.5. Planting ratio and border rows in case of hybrid seed plot. 6. Area of seed plot.
2) Flowering Stage	May be II,III,IV	1. Check of factors which were noticed during pre-flowering, inspection.2. Confirm isolation from the source of contamination and plot and calculation of area rejected if any on account of isolation requirement.3. Confirm observation on planting rations, border, rows, rougeing of off types, diseased plants, pollen shedders, detasseling made during preveious inspection. 4. Taking field counts for different specific requirements for prescribed for crop being inspected.
3) Post flowering and Pre-harvest Stage	May be III, IV, or V	1. Confirm the correctness of observation made in earlier inspection.2. Rougeing and taking field counts.3. Issue of instruction to seed grower for harvesting, drying, threshing, bulk packing, storage and transportation to seed processing plant. 4. Estimate seed yield.
4) Post harvest stage	Last	1. Verify in seed crops involving two parents that male parent rows have been separately and completely harvested and removed from the field and to seal if necessary the harvested male row produce. 2. Verify that the crop from the area rejected due to inadequate isolation or poor rougeing has been separately and completely harvested and removed from the field and to seal if needed the produce so harvested. 3. Avoidance of admixture of any type of contaminant at field stage threshing yard etc. 4. Sealing of threshed produce after initial cleaning and drying. 5. Instruction to the seed grower for sale storage and transportation.

Field Counts

It is a representative sample of plants taken at random from a seed plot for recording the observation on off types, pollen shedders, diseased plants, insprable other crop plants. As per provision of seed certification it is necessary to examine each and every plant in the seed plot for contaminant. It is however impracticable to do so. During each field inspection field counts are taken randomly covering of the seed plot and observations are made on the plants from each selected field counts.

The number of counts taken varies according to the area of the seed plot. Minimum five counts are required to be taken for seed plots having a 2.0 ha and one additional count is to be taken for every additional area of two hectare or part thereof.

Area of Seed Field (ha)	No of Counts to be taken
1. upto 2	5
2.2 to 4	6
3.4 to 6	7
4.6 to 8	8
5.8 to 10	9

6.10 to 12	10

Number of plants/heads or tillers to be included in one count depends upon the type of crop involved.

Crops	**Number of Plants /heads per Count**
1. Castor , Cotton, Groundnut, Maize, Tur, Sunflower, Bulb Crops, Tuber Crops, Broad Spaced Vegetables.	100 Plants
2. Beans , Pulses , seasamum , mustard,	500 Plants
3. Lucerne , Berseem, Jute, Soybean	1000 Plants
4. Cereals other than Maize	1000 Heads

Purpose of Seed Storage:

The purpose of seed storage is to maintain the seed in good physical and physiological condition from the time they are harvested until the time they are planted.

Stages of Seed Storage:

The seeds are considered to be in storage from the moment they reach physiological maturity until they germinate, or until they are thrown away because they are dead or otherwise worthless. The entire storage period can be conveniently divided into following stages.

1. Storage on plants (Physiologically maturity until harvest)
2. Harvest, until processed and stored in a warehouse.
3. In storages (Warehouses).
4. In transit (rail wagons , trucks, carts, railway sheds , etc)
5. In retail stores.
6. On the user's farm.

The seed quality, i.e germination and vigour, can be considerably affected at any of the stages mentioned above , unless sound principles involved in seed storage are practised and the seeds properly handled.

General Principles of Seed Storage

In view of the various factors affecting seed viability in storage, the following principles emerge as necessary for good storage.

a) Seed storage condition should be dry and cool.
b) Effective storage pest control.
c) Proper sanitation in seed stores.
d) Before placing seeds into storage they should be dried to safe moisture limits, appropriate for the storage system.
e) Storing of high quality seed only, i.e well cleaned , treated as well as of high germination with vigour and good pre-storage history.
f) Determine seed storage needs in view of period or length of storage time, and prevailing climate of the area during storage period.

Long term storage requires more exacting conditions of seed storage than short-term storage. Similarly, the regions with favourable storage climate, i.e one where relative humidity is rather low require less sophistication than areas of high relative humidity.

It is considerable importance to decide well in advanced how long it will be necessary to maintain the germination capacity of seed lot. Two types of problems that must be dealt with in seed storage are:

1. Pest Control
2. Environment

As the requirements become more exacting, the cost of storage facility per unit of seed stored increases rapidly.

Types of storage requirements. The types of storage needed can be related to the time of storage expected and can be classified into four types:

a) Storage of commercial seeds
b) Storage of carry-over seeds
c) Storage of foundation seed stocks
d) Storage for germ plasm seeds

a) Commercial Seeds:

The largest storage need 75 to 80 % is for the storage of seed from harvest until planting time, the next year. The storage period ranges from a few days to eight or nine months.

For most species, the requirements for seed storage are relatively simple. In the regions of no rainfall and low relative humidity, a smooth bare place may be reasonably satisfactory. However, loss from stealing, birds, and rodent s can be considerable and germination capacity can decline, at least in the surface seed, from heat damage and ultraviolet rays. Since it is not possible to have such a favourable climate every where, some shelter may be necessary. Such storage facilities can vary greatly. Successful storage structures and methods of storage for meeting the required needs should have following features.

i) Seeds placed in storage must be cleaned to free them of trash which may harbour insects or fungi and prevent free circulation of air.
ii) Seeds should be undamaged to minimise decline in vigour and germination.
iii) Seeds must be dried to a moisture content less than 14 percent for starchy seeds, and less than 11percent for oily seeds.
iv) Storage structure should be constructed so that the rain cannot enter, and that no serious gain in moisture will occur pests of stored seed should be effectively controlled if the following features for constructing warehouses are observed, and the other suggested measures are followed.

Construction Features for Good Seed Warehouse:

a) Warehouse should have no windows and have only one door constructed of metal which can be sealed properly and locked.
b) The material used for construction may be stone, concrete, brick, metal or wood. Regardless of the material, the foundation should be made of stone or concrete and should extend 90 cm above the ground level.
c) A lip around the building at the 90 cm height extending out 15 cm should also be constructed. Such construction makes entrance by rodents virtually impossible, as long as the foundation remains uncracked.
d) The floor must be paved and any cracks that may develop must be repaired.
e) Construction of the floor, walls and ceiling of the storage should be such that no cracks exist which can harbour insects. All cracks around openings, E.g Electric conduits, ventilation openings, and doors should be thoroughly sealed.
f) Ventilation openings should be screened against birds and insects.

Other Measures for Pest and Disease Control:

Sanitation:

Good sanitation in the seed store is necessary for protection from insects and rodents. The tom seed bags should either be immediately repaired or replaced with new bags to avoid spillage in warehouse. All spilled seeds or floor sweepings should be immediately removed. Discarded seed and cleanings should be carried away, not just dumped outside the door and left to harbour storage insects. In addition to cleanings, the floor and walls should be sprayed with a residual insecticide as often as required. In a well – maintained store, spraying once a year may be quite satisfactory. The recommended materials and rates are DDT –(50 percent WP) ½ to 1 lb/gal 1000 ft2 (1 to 2 g/m2) , Malathion (25 percent WP) 1lb/gal 1000 ft2 (1.25 g/m2). Malathion should not be used on such surface as brick, cement and concrete.

Seed Treatement:

An insecticide combined with a fungicide may be applied as a protectant. The most commonly used insecticide is DDT. DDT also has the advantage of long duration.

Fumigation:

Once the seed storage is completely free of insects, the most serious source of reinfestation is infested seed which is brought in seed may be brought from the field already infested, or it may be transferred from an infested storage. Such infestation is controlled by fumigation. Rather than fumigating the whole storage, it is better to have a fumigation room, or to fumigate the seed on a concrete floor under a tarpaulin before it enters the main storage room. The fumigation room should have its own door to the outside, and only after fumigation, should the seed be brought in to storage area.

Fumigation:

Fumigation is effective only in gas-tight storage. Numerous effective fumigants are available. However, there is a small safety margin between the dose that is toxic to insects and a dose that will cause loss of germination or vigour of seed. Reasonably safe fumigants at temperatures below 30 0 C and seed moisture below 12 % are the following (Parking , 1963).

Dosage	**Exposure Period**
Methyl Bromide 16 to 32 oz per 1000 ft3 (16 to 32 mg per cubic metre)	24 hours
Hydrogen cyanide 32 to 64 oz percent 1000 ft3 (32 to 64 mg per cubic metre)	24 hours
Hydrogen Phosphide 5 to 10 tablets per metric ton of seed (Phostoxin, Phosphine)	3 to 7 Days

It must be borne in mind that fumigation, particularly repeated fumigation, amy seriously reduce the vigour and even the germination capacity of seeds. This is particularly true of seeds with high moisture content. Seeds with moisture contents greater than 14 percent should be dried to below this value before fumigation. A high temperature also increases

damage to seeds by fumigants. Hence, fumigation should be used only with entering seeds, and all other measures should be used to maintain insect control in the stored seed. Prophylactic biweekly or monthly fumigation of seed storages can lead to serious germination problems. It is far better to build an insect- proof storage, and make certain that seeds, bags or anything else placed in the storage are insect –free. Of course, if a storage containing much seeds does become infested, then fumigation is required.

Seed Moisture Content:

To prevent damage from storage fungi, it is best to store seeds which have been well-dried to safe moisture content limits.

Factors Affecting Seed Longevity in Storage

1. Kind / variety of the Seed:

The seed storability is considerably influenced by the kind / variety of seeds. Some kinds are naturally short-lived, E. g onion , soybeans, peanuts , etc. some similar kinds, E. g Tall fescue and annual rye grass, though they look very much alike, differ considerably in storability, similarly, the genetic make-up of the lines/ varieties in the same kind also influences storability.

2. Initial Seed Quality:

The seed lots having vigorous, undeteriorated seeds store longer than deteriorated lots. Depending upon the severity of damage, or degree of deterioration, E. g extent of weathering damage, mechanical injury, flat, wrinkled or otherwise damaged seed, even seed lots of good germination, at the beginning of storage, can and do decline rapidly within a few months.

The important implication of this is that only high quality seed should be carried over. The mediocre quality seed may be retained only for the next plating seasons. The low quality seed should invariably be rejected.

3. Moisture Content:

The amount of moisture in the seeds is probably the most important factor influencing seed viability during storage, over most of the moisture range, the rate of deterioration increases as the moisture content on seed storability.

Moisture Content and Storage Life of Cereal Seeds at Temperatures not Exceeding 90 0 F for Seeds of High Germination and High Vigour at Start of Storage (Harrington and Douglas, 1970)

Seed Moisture Content Percent	**Storage Life**
11 to 13	½ Year

10 to 12	One Year
9 to 11	Two Years
8 to 10	Four Years

Further, if seeds are kept at higher moisture contents than mentioned in table the losses could be very rapid due to mold growth on and in the seed (12 to 14 per cent moisture content), or due to heating (18 to 20 per cent moisture content). Moreover, within the normal range, biological activity of seeds, in sects and molds further increases as the temperature increases. The higher moisture content of the seeds, the more they are adversely affected by both upper and lower ranges of temperature.

It is important to note that very low moisture content (below 4 per cent) may also damage seeds due to extreme desiccation.

Since the life of seed and its span largely revolves around its moisture content, it is necessary to dry seeds to safe moisture contents. The safe moisture content, however, depends upon storage length, type of storage structure, kind/verity of seed, type of packaging material used. For cereals in ordinary storage conditions for twelve to eighteen months, seed drying up to ten per cent moisture content appears quite satisfactory. However, for storage in sealed containers, drying up to 5 to 8 per cent moisture content, depending upon the particular kind, may be necessary.

4. Relative Humidity and Temperature During Storage:

Relative humidity and temperature by far are the most important factors determining the storage life of seeds. Seed attain a rather specific and characteristics moisture content when subjected to given levels of atmospheric humidities. This characteristics moisture content is referred to as equilibrium moisture content, for a particular kind of speed at a given relative humidity, tends to increase as temperature decreases and as deterioration progresses. Thus the maintenance of speed moisture content during storage is a function of relative humidity and to a lesser extent of temperature, at equilibrium moisture content, there is no net gain or loss in seed moisture content. Seed placed in an environment with a relative humidity higher or lower than that with which its moisture content is in equilibrium , will gain or lose moisture until an equilibrium is established with the new environment . In sealed storage, seed moisture content determines the relative humidity of the environment in the containers.

Establishment of moisture equilibrium in seeds is a time dependent process. It does not occur instantaneously. A period of time is required, the length of which varies with the seed kind, initial moisture content, the average relative humidity and the temperature. Under open storage conditions, seed moisture content, fluctuates with changes in relative humidity. However, normal diurnal fluctuation in relative humidity have little effect on moisture content. Table gives the equilibrium moisture content for important field and vegetable crops.

Absorbed Moisture Content of Cereals Seeds in Equilibrium with air (Harrington, 1959):

Sr.No	**Crop**	**15%**	**45%**	**75%**	**100%**
1	Shelled Maize	6.4	10.5	14.8	23.8
2	Rice, Milled	6.8	10.7	14.4	23.6

3Sorghum	6.4	10.5	15.2	21.9
4Wheat Hard Red				
5Winter	6.4	10.5	14.6	25

Approximate Moisture Content of Vegetable Seeds in Equilibrium with Air

Sr.NoCrop	**20%**	**30%**	**45%**	**75%**
1Garden Beet	4	5.8	7.6	11.2
2Cabbage	4.6	5.4	6.4	9.6
3Okra	7.2	8.3	10	13.1
4Onion	6.8	8	9.5	13.4
5Peas	7.3	7.3	10.1	15

Temperature also plays an important role in life of seed, although if does not appear to be a controlling one. Within the normal range of biological activity of seeds, insect and moulds increases as temperature increases. The higher the moisture content of the seeds, the more they are adversely affected by temperature. Decreasing temperature and seed moisture, therefore, is an effective means of maintaining seed quality in storage.

Low temperatures are very effective in maintaining seed quality, even through relative humidity might be quite high. Good cold storage for seed should not exceed sixty percent in relative humidity.

5. Provenance:

It has already been stated that a number of factors, operating before and during harvest can affect seed viability. It is suprising then that samples of seed obtained from different sources may show differences in viability behaviour. It is not always easy to know and satisfactorily assess what the causes of these differences are, or even sometimes to know how important they are, because of wide variability between samples from different sources.

Nevertheless, the seed begins its existence before it is harvest. And it is only to be expected that seeds harvested in different pre-harvest condition which will have caused different amounts of deterioration by the time seeds are harvested.

6. Effects of Fluctuating Environment Conditions on Viability:

There have been a few reports to the effect that fluctuating conditions are harmful, however, at present there is not a priori reason to suppose that change in temperature, or moisture content , would in itself be deterious save, possibly , for very rapid changes in seed moisture content.

More critical investigations are needed on the effect of fluctuating environmental conditions.

7. Special Effect of Extreme Storage Conditions on Viability:

Researches indicate that three sets of extreme storage conditions of temperature and moisture contents, say about 30 percent, in cereals provided the temperature is suitable, germination will result in loss of viability when seeds are very moist, thirdly , if seeds are subjected to extreme desiccation , the period of viability may be less than expected.

8. Oxygen Pressure:

Recent researches on the role of a gaseous environment on seed viability indicate that increases in pressure of oxygen tend to decreases the period of viability. The little work carried out on the use of antioxidants shows that heat injury to kidney bean embryos was decreased in reduced oxygen pressures, and that the application of cysteine overcame the injury to some extent. Onion and okra seeds treated with either starch phosphate or alphatocopherol suggest that starch phosphate is very effective in prolonging the viability of both spp, and alphatocopherol had some beneficial effect on onion seeds. Effect of Storage Condition on the Activity of Organisms Associated with Seeds in Storage:

There are six main types of organism associated with seeds in storage, namely, Bacteria- Fungi-Mites- Insects- Rodents- and Birds.

The activity of all these organism can lead to damage resulting in loss of vigour or viability or, particularly in the case of rodents, to complete loss of seed.

Bacteria and fungi. The important consideration in the control of seed micro flora, is the relative humidity of the inter-seed atmosphere. Researches indicate that all storage fungi are completely inactive below 62 percent relative humidity and that there is very little activity below about 75 percent relative humidity upwards, the amount of fungi in a seed often shows an exponential relationship with relative humidity. The storage bacteria require at least 90 percent relative humidity for growth and they , therefore , only become significant under conditions in which fungi are already very active.

With regard to effect of temperature on the growth of the micro-flora, certain organisms can grow at temperatures as high as 80 0 C. Consequently , since high temperatures rapidly decreases seed viability , the only practical method of controlling micro-flora activity by temperature alone is by deep freezing. At this time there are no satisfactory chemical methods of control of these organisms in storage.

Insect and Mites: There is no insect activity at seed moisture contents below 8 percent , but if grain is infected, increased activity may generally be expected upto about 15 % moisture content. The optimum temperatures for insect activity of more important storage insects ranges from 28 to 38 0 C. The temperatures below 17 to 22 0 C are considered unsafe for insect activity.

Although it is normally preferable to control insect and mite activity by the manipulation of the seed environment, it is possible to effect some control of these organism chemically, i.e through the use of fumigants and contact insecticides. One of the problems of chemical control is that the chemicals can have an adverse effect on seed viability, or vigour , and some of them are dangerous to handle. Nevertheless, fumigants which have been used successfully include methyl bromide, hydrogen cyanide, phosphine, ethylene dichloride and carbon tetrachloride in 1 3:1 mixture, carbon disulphide and naphthalene. Contact insecticides – used in seed storage include DDT, lindane and Malathion.

Rodents and Birds. Birds can be a constant source of seed loss, if even small openings exist at the lanes, or between the roof tiles. All openings should be sealed, or screened, if needed for ventilation. Rats and other rodents are more serious problems. Rodents may result into a complete loss of seed. Rodent , control measures include building the store so that the floor is 90 cm above ground level at the entrances ; having a 15 cm lip around the building at the 90 cm level of the floor; and providing a removable deck at the entrance for use only when seed is being loaded or unloaded.

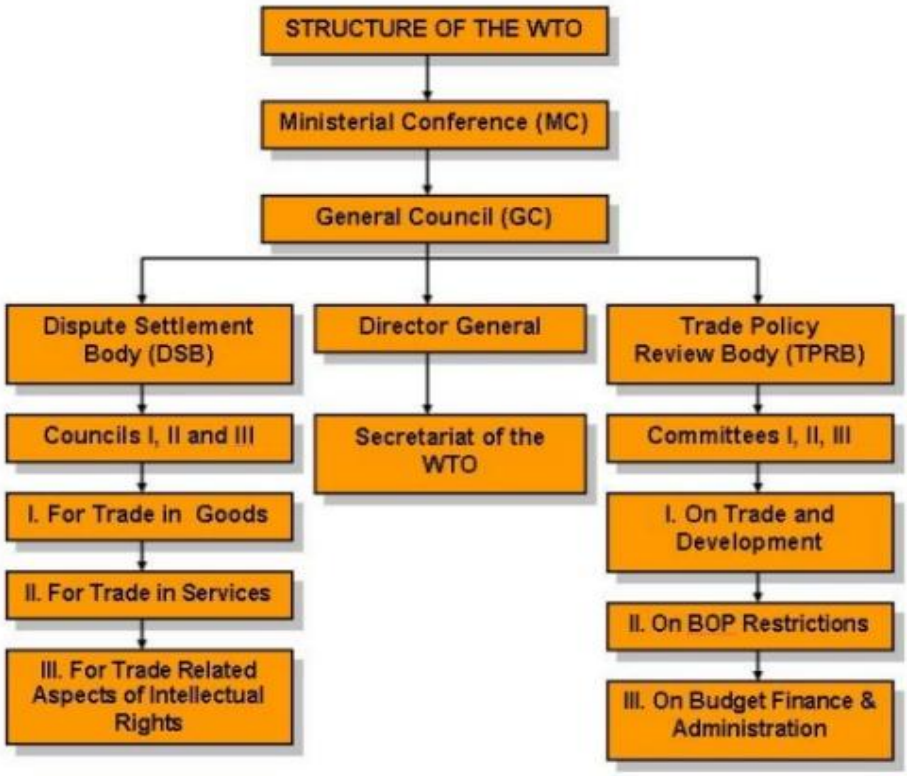
9. Other Factors:

Factors besides those discussed above that affect storage life are the direct sunlight on the seed, number of times and kind of fumigation, effect of seed treatment, etc.

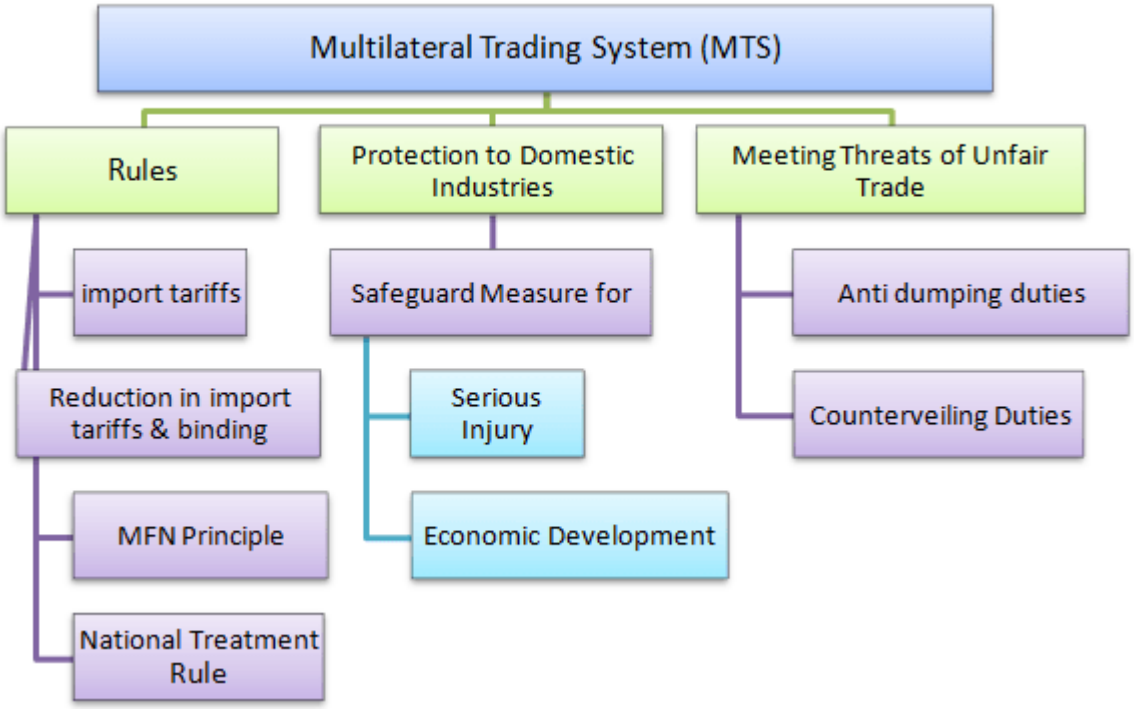
9. Storage in Transit, at the retailer's store and user's farm. It does little good to construct excellent warehouses if the seeds lose their viability subsequently by improper storage in transit, or at the retail store, or at the user's farm. Adequate storage precautions at all these points, therefore, are also necessary.

8. WTO Trade Agreement

The WTO is an inter-governmental organization for governments to negotiate global trade agreements and progressively liberalizing trade. Currently, WTO has 164 members. The WTO operates a system of trade rules *that apply to all its members.* The WTO is also a place for Member governments to settle their trade disputes. Its hq located in Geneva, Switzerland. It was established on 1 January 1995 and its official languages are English, French and Spanish.



Organizational Structure of WTO



Objectives of WTO

WTO wishes to achieve the following objectives through the multilateral trading system:

- Raise living standards
- Ensure full employment
- Ensure a large and steadily growing volume of real income and effective demand
- Expand the production of and trade in, goods and services, while allowing for the optimal use of the world's resources in accordance with the objective of sustainable development.

History of WTO

The history of the WTO begins with the signing of the **General Agreement on Tariffs and Trade** (GATT) in 1947. From 1948 to 1994, GATT provided the rules for the bulk of world trade and presided over periods that saw some of the highest growth rates in international trade.

Please note that the initial objective was to create an **International Trade Organization** (ITO) to handle the trade side of international economic cooperation, joining the two "Bretton Woods" institutions, the **World Bank** and the **International Monetary Fund**. The efforts to establish the ITO failed and the GATT served for several years as an organization, taking some of the functions originally intended for the ITO.

The GATT developed rules for the MTS through **eight rounds of trade negotiations**. In the early years, the GATT trade rounds focused on reducing tariffs. Following GATT trade rounds covered not only tariffs, but also other trade barriers. During the GATT rounds, substantial liberalization for international trade in goods was achieved and fundamental rules were established on the basis of an open and non-discriminatory trading system.

WTO Trade Agreements

There are more than different 60 agreements overseen by the WTO. Any country which is accessing to WTO must sign and ratify all WTO agreements. we are discussing here agreements as follows:

- The Agreement on Agriculture (AoA)
- Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)
- Agreement on the Application of Sanitary and Phytosanitary Measures (SPS)
- Agreement on Technical Barriers to Trade (TBT)
- Agreement on Trade Related Investment Measures
- General Agreement on Trade in Services (GATS)

Agreement on Agriculture (AoA)

The Agreement on Agriculture (AoA) was negotiated during the **Uruguay Round** of the General Agreement on Tariffs and Trade, and entered into force with the establishment of the WTO on January 1, 1995. It aims at reforming trade in agriculture, envisaging a fair and market-oriented system, which improves predictability and stability for both importing and exporting countries.

Three Pillars of Agreement on Agriculture (AoA) under WTO

The Agreement allows governments to support their rural economies, but preferably through policies that cause less trade "distortions".

The Agreement on Agriculture applies not only basic agricultural products (such as wheat and live animals), but also the products derived from them (such as flour and meat), as well as most processed agricultural products (e.g. chocolate and sausages). The coverage of the Agreement also includes wines, spirits and tobacco products, as well as fibres (such as cotton). **Fish and fish products are not included, nor are forestry products**. **These products are covered by the Non-Agricultural Market Access (NAMA) negotiations of the World Trade Organization, based on the Doha Declaration of 2001**. Agreement on Agriculture has three pillars.

Market Access – Tariff Only

The market access rule for agricultural products is "tariffs only". This means *that all non-tariff measures were to be either removed or to be replaced by tariffs*, reflecting substantially the same level of protection (this process is called "tariffication"). As per the AoA, the WTO Members committed to set tariff bindings to agricultural products and assumed reduction commitments on tariffs, which are contained in each Member's WTO Schedule of concessions on goods (Article 4).

- Different reduction commitments applied to developing and developed Members. At the same time, please note that the LDCs were not required to reduce their tariffs.

Domestic support (Subsidies)

This pillar is based upon the assumption that not all subsidies distort trade to the same extent. The Agreement distinguishes between two categories of domestic support:

- Domestic support with no, or minimal, distorting effects on trade – not subject to reduction commitments. These were kept in **Green Box** and **Blue Box Measures**.
- Domestic support with distorting effects on trade – subject to limits and reduction commitments. These were kept in Amber Box measures.

The green, Blue and Amber box subsidies are discussed below:

Green Box Subsidies

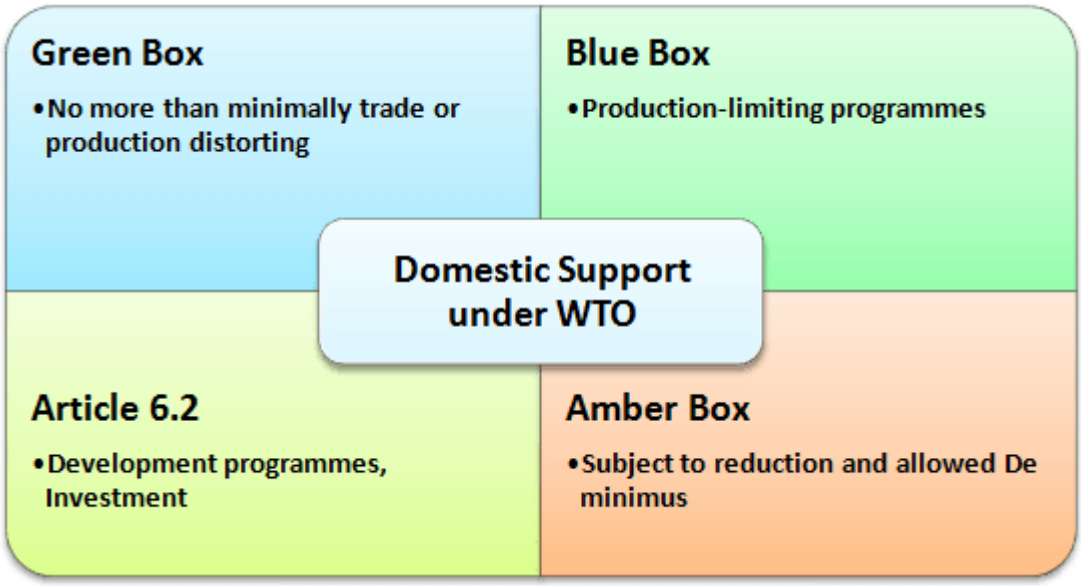
Green box subsidies are those subsidies which cause no, or at most minimal, trade distorting effects or effects on production. These include the amounts spent on Government services such as research, disease control, and infrastructure and food security. This also includes the subsidies given to the farmers that directly don't affect international trade badly. Since they are permitted in WTO regime, the most developed countries have kept providing subsidies to their farmers. The Green Box contains fixed payments to producers for environmental programs, so long as the payments are "decoupled" from current production levels.

Blue Box Subsidies

Blue Box contains direct payment subsidies which can be increased without limit, so long as payments are linked to production-limiting programs

Amber Box Subsidies

All domestic support measures considered to distort production and trade (with some exceptions) fall into the amber box The provisions accepts 5% of agricultural production for developed countries, 10% for developing countries. The Amber box subsidies with conditions designed to reduce distortion are placed in Blue Box. They include the direct payment to the farmers to reduce production. Apart from the above, there are Article 6.2 subsidies for **Development Programmes**.



Export Competition

Export subsidies are presumed to have trade-distorting effects. They allow exporters, benefited with such subsidies, to sell below the cost of production. In that way, export subsidies reduce world prices, undercutting exporters in other countries. The Agreement on

Agriculture prohibits the use of export subsidies for agricultural products, unless a Member has reserved the right to use export subsidies in its WTO Schedules of concessions.

Agreement on the Application of Sanitary and Phytosanitary Measures (SPS)

The SPS agreement was negotiated during the Uruguay Round. Under the SPS agreement, the WTO sets constraints on member-states' policies relating to food safety (bacterial contaminants, pesticides, inspection and labelling) as well as animal and plant health (phytosanitation) with respect to imported pests and diseases.

Sanitary and Phytosanitary measures, as well as products' technical regulations,*may result in restrictions to trade*. It is recognized that such measures may be necessary to serve legitimate objectives, such as to ensure food safety or to protect human, animal or plat life or health. However, these measures may sometimes go beyond what is needed to protect such objectives and be used to shield domestic producers from foreign competition. Some believe that the use of such types of measures for protectionist purposes is likely to increase whenever import tariffs on goods are reduced.

Sanitary and phytosanitary measures can take many forms such as requiring products to come from a disease free area, safety inspection or setting of allowable maximum levels of pesticides residues. They apply to domestically produced food or local animal and plant diseases, as well as to products coming from other countries. *Please note that under SPS agreement, burden of proof is on members to demonstrate scientifically that something is dangerous before it can be regulated. If there is no scientific proof, WTO would override the right of the country to impose such restrictions.*

Agreement on Technical Barriers to Trade (TBT)

The Agreement on Technical Barriers to Trade was last renegotiated during the Uruguay Round. TBT exists to ensure that technical regulations, standards, testing, and certification procedures do not create unnecessary obstacles to trade. The agreement prohibits technical requirements created in order to limit trade, as opposed to technical requirements created for legitimate purposes such as consumer or environmental protection. The TBT agreement is closely linked to the SPS agreement.

The TBT Agreement covers technical regulations on quality, packaging and labelling also. If a producer in country A wants to export to country B, it will be obliged to satisfy the technical requirements that apply in country B, with all the financial consequences this entails. Having many different regulations and standards involves significant costs for producers and exporters. In addition, in the absence of international disciplines, a risk remains that TBT measures could be used as an excuse for protectionism.

The TBT Agreement recognizes that no Member shall be prevented from taking measures necessary to fulfil a legitimate objective, including the protection of human, animal or plant life or health, the protection of the environment or the prevention of deceptive practices. WTO Members may protect other legitimate objectives (e.g. ensure quality of products), provided they comply with the TBT Agreement.

Agreement on Trade-Related Investment Measures (TRIMS)

Agreement on Trade Related Investment Measures (TRIMS), resulting from the Uruguay Round, recognizes that certain investment measures may cause restrictive effects on international trade in goods. Policies such as local content requirements and trade balancing rules that have traditionally been used to both promote the interests of domestic industries and combat restrictive business practices were major focus.

The main obligation contained in Agreement is that Members shall not apply any trade-related investment measure that is inconsistent with Article III (national treatment) or Article XI (general elimination of quantitative restrictions) of the GATT. The following have been explicitly Prohibited by the TRIMs Agreement:

- **Local content requirement:** Measures requiring the purchase or use by an enterprise of domestic products.
- **Trade balancing requirements:** Measures requiring that an enterprise's purchases or use of imported products be limited to an amount related to the volume or value of local products that it exports
- **Foreign exchange restrictions:** Measures restricting the importation by restrcting access to foreign exchange
- **Domestic sales requirements:** Measures restricting the export in proportion of volume or value of its local production.

Please note that Developing countries are permitted to retain TRIMs by virtue of the economic development needs of developing countries.

Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS)

Today, the intangible assets are becoming increasingly important. These assets which are the result of human intellectual creative activity such as invention, design, know-how, and artistic creation are known as "intellectual property."

Among the forms of intellectual property specifically entitled to legal protection are*inventions, trademarks, designs, literary works, layout-designs of integrated circuits and trade secrets*. As the volume of trade in goods and services involving intellectual property has increased greatly in recent years, the importance of the protection of intellectual property for the world economy has grown enormously. Inappropriate and insufficient protection of intellectual property can distort free trade.

In the developing countries, the protection of intellectual property rights has been often insufficient. Developing countries often limit protection to a very narrow subject area, or provide protection for only a short period of time, or lack strict enforcement. In contrast, the developed countries have problematic intellectual property regimes that, for example, openly discriminated against foreign nations, provide excessive protection or otherwise have regimes so different from those employed by the rest of the world that its effect is discriminatory.

The WTO sought to establish an appropriate framework for the protection of intellectual property in order to bring greater order to international trade. A number of international treaties already form a common legal framework for the protection of intellectual property, including the **Paris Convention** (1883) and covers patents, trademarks and other industrial property rights, the **Berne Convention**(1886) and covers copyrights.

Recently, however, as countries pay more attention to the trade related aspects of this subject, they have frequently placed intellectual property protection on the agenda of trade negotiations. Countries recognized that as many governments as possible should take part in framing an international agreement establishing standards for the trade aspects protecting intellectual property. As a result, GATT negotiators instituted negotiations on the Trade-Related Aspects of Intellectual Property Rights (TRIPS) one of the most important new areas included in the Uruguay Round negotiations. A final consensus on the TRIPS Agreement was reached in Marrakesh in April 1994 and took effect on 1 January 1995.

Some important Notes on TRIPS are as follows:

- TRIPS covers all legally-recognized intellectual property rights (copyright and related rights, patents, industrial designs, trademarks, geographical indications, layout-designs of integrated circuits and undisclosed information)
- The TRIPS Agreement incorporates and improves upon protection levels of the Paris Convention (industrial property rights) and the Berne Convention (copyright).
- In the area of copyrights and related rights, the TRIPS Agreement specifies the protection of computer programmes (protected as literary works under the Berne Convention) and rental rights.
- The TRIPS Agreement contains provisions governing the protection of trademarks, geographical indications, industrial designs, layout-designs of integrated circuits, and undisclosed information. It also contains rules on anti-competitive practices in contractual licenses.
- Developed countries were given a transition period of one year from the date of entry into force of the WTO Agreement; developing countries and transformation countries were given five years (until January 2000); and least-developed countries were given 11 years (until January 2006).
- TRIPS Agreement is to date the most comprehensive multilateral agreement on intellectual property (IP).
- The TRIPS Agreement is based on the main conventions of the World Intellectual Property Organization (WIPO). Most of the provisions of these conventions have been incorporated into the TRIPS. The TRIPS Agreement includes however, a number of additional obligations where the pre-existing conventions are silent or inadequate.

General Agreement on Trade in Services (GATS)

The General Agreement on Trade in Services (GATS) requires most-favoured-nation Treatment, market access commitments and national treatment. GATS was agreed upon at the end of the Uruguay Round negotiations with the participation of all Member nations including developing countries. The GATS covers a wide range of service industries such as financial services, transport and shipping, communications, construction, and distribution. The GATS distinguishes between four modes of supplying services: cross-border trade, consumption abroad, commercial presence, and presence of natural persons. They have been defined as follows:

Mode 1: Cross-border supply

- Cross-border supply is defined to cover services flows from the territory of one Member into the territory of another Member
- Example: Banking or architectural services transmitted via telecommunications or mail

Mode 2: Consumption abroad

- Consumption abroad refers to situations where a service consumer (e.g. tourist or patient) moves into another Member's territory to obtain a service
- Example : Various kinds of tourism activities

Mode 3: Commercial presence

- Commercial presence implies that a service supplier of one Member establishes a territorial presence, including through ownership or lease of premises, in another Member's territory to provide a service

- Example: Domestic subsidiaries of foreign insurance companies or hotel chains

Mode 4: Presence of a natural person

- Presence of natural persons consists of persons of one Member entering the territory of another Member to supply a service
- Movement of skilled persons such as accountants, doctors or teachers